(bilateral Hankel) operators acting on L^2 of the circle. Accordingly, a different approach is needed to obtain operators on C^n that could more correctly be labeled Toeplitz (Hankel) operators; and we hope to return to this topic at an another time. For now, we hope that the notion of aliases of such operators will prove beneficial to those interested in applications.

REFERENCES

1 A. Brown and P. Halmos, Algebraic properties of Toeplitz operators, *J. Reine Angew. Math.* 213:89–102 (1964).
2 J. W. Cooley and J. W. Tukey, An algorithm for the machine calculation of complex Fourier series, *Math Comp.* 19:297–301 (1965).
3 P. J. Davis, *Circulant Matrices*, Wiley, New York, 1979.
4 R. G. Douglas, *Banach Algebra Techniques in Operator Theory*, Academic, New York, 1972.
5 P. Hartman and A. Wintner, On the spectra of Toeplitz's matrices, *Amer. J. Math.*, 72:359–366 (1950).
6 ______, The spectra of Toeplitz's matrices, *Amer. J. Math.* 76:867–882 (1954).
7 I. S. Iohvidov, *Hankel and Toeplitz Matrices and Forms, Algebraic Theory*, Birkhäuser, Boston, 1982.
8 V. V. Peller, Hankel operators of the class $\mathfrak{S}_p$ and their applications (rational approximation, Gaussian processes and the problem of majorizing of operators), *Math. USSR—Sb.* 41:443–479 (1980).
9 V. V. Peller and S. V. Khrushchev, Hankel operators, best approximations and stationary Gaussian processes, *Russian Math. Surveys* 37(1):61–144 (1982).
10 S. C. Power, *Hankel Operators on Hilbert Space*, Research Notes in Math., No. 64, Pitman, Boston, 1982.
11 G. Szegö, A Toeplitz féle formákról, *Mathematikai és természettudományi ertesetö*, 35:185–222 (1917).
12 H. Widom, *Toeplitz Matrices*, Studies in Real and Complex Analysis, Vol. 3, MAA Studies in Mathematics, 1965.
13 H. S. Wilf, *Finite Sections of Some Classical Inequalities*, Ergebnisse der Mathematik und ihrer Grenzgebiete, Band 52, Springer, New York, 1970.

An Introduction to Sparse Matrices

Derek O'Connor
Management Information Systems Department
University College
Dublin, Ireland

In this short review talk, sparse matrices were introduced and shown to arise in many areas of applied and computational mathematics. The reasons for exploiting sparsity were discussed briefly.

Storage of sparse matrices was discussed, and some standard static and dynamic storage schemes outlined.

Iterative and direct methods of solving linear equations were briefly outlined and then discussed in the context of exploiting their sparsity.

The last section dealt with the direct solution of sparse symmetric positive definite systems of equations. It was shown that the problem of solving such equations can be decomposed into a nonnumeric part and a numeric part. The nonnumeric part is the problem of ordering (relabeling) the variables so that fill-in is minimized during the numeric part, viz. Cholesky's method, a symmetric form of Gaussian elimination.

Eigenvalue, least-squares, and optimization problems were not discussed.

We give here a list of references on the material of the talk.

REFERENCES

1 J. R. Bunch and D. J. Rose (Eds.), *Sparse Matrix Computations*, Academic, 1976.
2 I. S. Duff, A survey of sparse matrix research, *Proc. IEEE* 65:500–535 (1977).
3 I. S. Duff (Ed.), *Sparse Matrices and their Uses*, Academic, 1981.
4 I. S. Duff and G. W. Stewart (Eds.), *Sparse Matrix Proceedings, 1978*, SIAM Publ., 1979.
5 G. Forsythe and C. Moler, *Computer Solution of Linear Algebraic Systems*, Prentice-Hall, 1967.
6 A. George and J. W. Liu, *Computer Solution of Large Sparse Positive Definite Systems*, Prentice-Hall, 1981.
7 D. J. Rose, A graph-theoretic study of the numerical solution of sparse positive definite systems of linear equations, in *Graph Theory and Computing* (R. Read, Ed.), Academic, 1973.
8 D. J. Rose and R. E. Tarjan, Algorithmic aspects of vertex elimination on directed graphs, *SIAM J. Appl. Math.* 34:176–197 (1978).
9 D. J. Rose and R. A. Willoughby (Eds.), *Sparse Matrices and their Applications*, Plenum, 1972.
10 R. E. Tarjan, Graph theory and Gaussian elimination, in [1], pp. 3–22.
11 R. S. Varga, *Matrix Iterative Analysis*, Prentice-Hall, 1962.
12 R. Willoughby (Ed.), *Sparse Matrix Proceedings*, IBM Research, 1968.

Unmixed solutions of the algebraic Riccati equation

H. K. Wimmer
Mathematical Institute
University of Würzburg, Germany

Let A, C, D, and X be complex $n \times n$ matrices such that C, D, and X are Hermitian and $D \geqslant 0$ (positive semidefinite). A solution X of the alge-